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Performing Industrial Base Analyses

Volume I: Methodology

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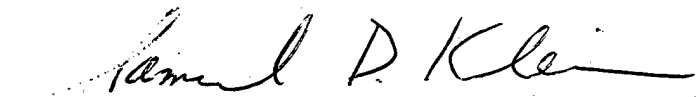

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In November 1994, the Secretary of the Navy asked the Assistant Secretary of the Navy (Research, Development and Acquisition) [ASN(RD&A)] to assess the minimum essential industrial base that the Department must sustain. The assessment was to become part of the FY97 Program Review (PR-97). In turn, ASN(RD&A) asked CNA to help support the assessment process. In addition to PR-97 support, the sponsor asked CNA to develop a framework for addressing industrial base questions because the Navy Department is required to perform many of these industrial base assessments. This paper proposes a CNA methodology for conducting industrial base studies. It is designed as an instructional document to guide analysts in capturing economic sources of industrial base risks. This framework helps to identify likely problems and then to tailor feasible solutions. The framework is general enough to be applied to a wide variety of industrial base items. The goal of this paper is to separate the important factors regarding the industrial base from the extraneous ones. By highlighting the key elements and economic dynamics, the methodology can support Navy and Marine Corps decisions on critical industrial base issues.

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Contents

Introduction

In November 1994, the Secretary of the Navy asked the Assistant Secretary of the Navy (Research, Development and Acquisition) [ASN(RD&A)] to assess the minimum essential industrial base that the Department must sustain. The assessment was to become part of the Fiscal Year 1997 Program Review (PR-97). In turn, ASN(RD&A) asked CNA to help support the assessment process. In addition to PR-97 support, the sponsor asked CNA to develop a framework for addressing industrial base questions because the Navy Department is required to perform many of these industrial base assessments.

This paper proposes a CNA methodology for conducting industrial base studies. It is designed as an instructional document to guide analysts in capturing economic sources of industrial base risks. This framework helps to identify likely problems and then to tailor feasible solutions. The framework is general enough to be applied to a wide variety of industrial base items.

The goal of this paper is to separate the important factors regarding the industrial base from the extraneous ones. By highlighting the key elements and economic dynamics, the methodology can support Navy and Marine Corps decisions on critical industrial base issues.

Deviations from competitive markets cause most industrial base risks. There are two general concerns: those stemming from concentrated demand and those from concentrated supply. Concentrated demand gives rise to what we term "responsiveness/capacity risk"—when industry does not have the capability to respond quickly to changing military requirements, especially ramp-ups. A concentrated number of suppliers may give rise to "bargaining risk" and "disruption risk." Bargaining risk occurs when suppliers can gouge the Navy Department regardless of their production capacity. Disruption risk applies to industrial facilities that become exceptionally vulnerable to physical attacks and other disasters.

There are two companion papers. Reference [1] is an annotated bibliography of the relevant industrial base literature. Reference [2] presents two case studies, on surface combatant platforms and torpedoes, to demonstrate how researchers can use the methodology.

This paper is organized as follows. First, we provide an overview of the industrial base methodology. The next section is a theoretical discussion of the sources of industrial base risks. Subsequent sections detail the methodology stages, which include filtering the industrial base items, diagnosing industrial base risks, and developing solution strategies. A concluding section summarizes the benefits of using the methodology.

Methodology overview

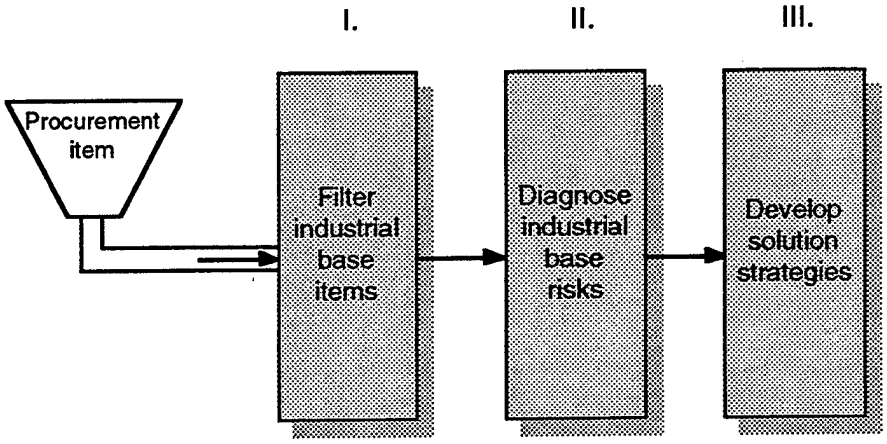
This paper provides a framework for conducting industrial base studies. Although designed to aid in the analysis of procurement items, it is comprehensive enough to apply to other phases of the development process, including research, testing, evaluation, and maintenance.

The recommended methodology has three stages:

- An **initial filter** to hone item definition and assess importance
- **Demand and supply templates** to diagnose industrial base risks
- **Solution strategies** for coping with identified risks.

Figure 1 shows the overall methodology.

Figure 1. Overall methodology



The filter is a series of preliminary questions to help define the industrial base item. While the methodology will work for any procurement item, some may be inordinately large or small. These questions try to

refine the problem so that it is appropriate for an industrial base study. The filter also tries to develop some measure of the item's importance. The more critical the item, the more attention may need to be paid to its industrial base.

Once the item is properly defined, its demand and supply conditions are examined. This task is guided by two templates. The templates are a series of questions designed to focus attention on key economic issues and to filter out extraneous ones.

Together, the filter and the templates trace the sources of industrial base risks and describe their likely effects and severity. A decision-maker then can conclude whether the risks are great enough to warrant Navy Department or other government action. The templates are there to ensure that all the relevant issues are clearly laid out.

If the risks are indeed severe enough to warrant action, the paper provides guidance for developing solutions. By first identifying the specific sources of industrial base risks, the methodology can lead researchers toward feasible solution strategies. The templates also form a baseline for assessing these policy solutions. The researchers then can evaluate the solutions further according to their costs, benefits, and risks.

Sources of industrial base risks (theory)

Concerns about the defense industrial base are not over just one sort of risk, but several distinct types of risks. These risks tend to have different causes and different solutions. Before one can propose an effective policy, one first has to identify the specific risks involved.

Most industrial base risks are caused by deviations from competitive markets. There are two general concerns: those stemming from concentrated demand and those from concentrated supply.

Concentrated demand concerns

Concentrated demand concerns arise when the Department of the Navy (DON) is the sole or primary purchaser of a good. The industry essentially exists to support Navy or Marine Corps needs. This extreme reliance by the industry on the military entails some risk to the DON, notably what we term a "responsiveness/capacity risk."

Responsiveness/capacity risk

Responsiveness/capacity risk occurs when the industry does not have the capability to respond quickly to changing Navy or Marine Corps requirements, especially potential ramp-ups. When an industry produces solely for the Navy Department, its capacity will be sized to meet DON purchases. If procurements drop, the industry may shrink or disappear. If Navy or Marine Corps requirements suddenly increase, the industry may not be able to respond rapidly enough.

A wider customer base insulates an industry from declining military procurements while allowing it to respond more rapidly to any ramp-ups. For example, nearly every industry has some capability to increase production, if only by adding a second or third shift. If the industry is sized to produce solely for the Navy Department, its capacity to increase production quickly may be limited. However, if the

DON is just one of many customers, the industry overall will be much larger. In this case, adding another shift could increase total output enormously relative to Navy or Marine Corps needs. As a numeric example, assume an industry can increase production by 20 percent by adding overtime. If the Navy Department is the sole purchaser, industry can increase production by 20 percent over normal DON demand. On the other hand, if Navy and Marine Corps demand accounts for only 10 percent of the market, industry overtime production of 20 percent translates into an increase of 200 percent over normal DON demand.

Responsiveness/capacity risk is a function of the number of customers in a market, not the number of firms or facilities. In economic equilibrium, industry output will be sized to meet overall demand. It is possible in some cases that one large firm may be capable of expanding output faster than two small firms, or that one large facility may be more flexible than two small ones.

When the DON is the sole purchaser (monopsonist) of an item, it has enormous power over market structure. Its contracting policies and procedures determine expected profits and the willingness of firms to invest privately in anticipation of future requirements [3].

A monopsonist buyer with competitive suppliers is not a fair game. Once suppliers make sunk investments in unique plant and equipment, the monopsonist may try to deny them sufficient profits. If the investments cannot be used for any other purpose, the suppliers are stuck. They must accept whatever the monopsonist pays or go out of business. Firms may be very wary of investing under such circumstances.[1]

Concentrated supply concerns

Concentrated supply concerns arise when there is one or very few competitors in an industry. Having few suppliers makes the Navy

1. Monopsony is usually described regarding labor in a one-company town, but the arguments are directly analogous. Reference [4] contains a good discussion.

Department vulnerable to two types of risks: "bargaining risk" and "disruption risk."

Bargaining risk

When there is a single or very few firms in an industry, those firms may have significant market power. Even when firms have sufficient capacity to meet Navy Department needs, they may use their market power to hold out for excessive profits. This is a bargaining risk: Industry can produce, but gouges the Navy and Marine Corps.

Market power of this sort typically comes from one of two sources: entry barriers or scale economies.[2] The source of the firm's market power will affect its behavior and the cost-effectiveness of DON industrial base policies.

Barriers to entry, such as licenses or special regulations, can shield a firm from competition. Protected firms are essentially free to charge whatever price they wish. They have a profit-maximizing incentive to exploit their privileged status and gouge their customers.

Highly concentrated industries that have no barriers to entry typically result from economies of scale or scope. Here, large-scale production of one item or several related items may be the most efficient production technique. Natural market forces will lead to a few large firms that could try to gouge customers. Smaller firms would be discouraged from competing in the market because they would have to produce on an inefficiently small scale.

Bargaining risk is not directly related to industrial capacity or the number of facilities. A single firm may have many facilities and sufficient capabilities to respond quickly to changing demand. The key factor is the contestability of the market—the number of firms currently participating in the industry and the ease with which new firms can enter.

2. Reference [5] contains a fuller enumeration of the causes of monopoly.

Disruption risk

Disruption risk is typically an extreme version of supply concentration. Here, industry downsizes the number of physical facilities to the point where they become vulnerable to potential disruptions. These potential disruptions include terrorist attacks, sabotage, acts of war, natural disasters, fires, and labor disputes.

Although bankruptcies typically are included in the lists of possible disruptions, they are actually somewhat different in nature. A bankruptcy is essentially a transfer of assets from stockholders to creditors. It may increase uncertainty, but it does not always mean an interruption for customers. Problems arise when the Navy Department accepts a contract with an unreasonably low price. If the contract itself is profitable, it will be in the creditors' interest to complete work. It is only when the contract is not profitable that the DON may be forced to have others finish the work, incurring additional expense and delay. Reference [6] discusses how profitable lines of business remain after closure. Bankruptcies are not so much an industrial base problem as a call for contracting reform. The best way to avoid problems may be to ensure that bids are realistic and suppliers are reputable.

Although disruption risks are usually associated with concentrated supply, they are not exclusively so. Having many firms in an industry does not always eliminate risk. Firms may locate in one area, making them especially vulnerable to a single natural disaster. An example is Silicon Valley in California, where many different computer companies are located and would be jointly vulnerable to an earthquake.

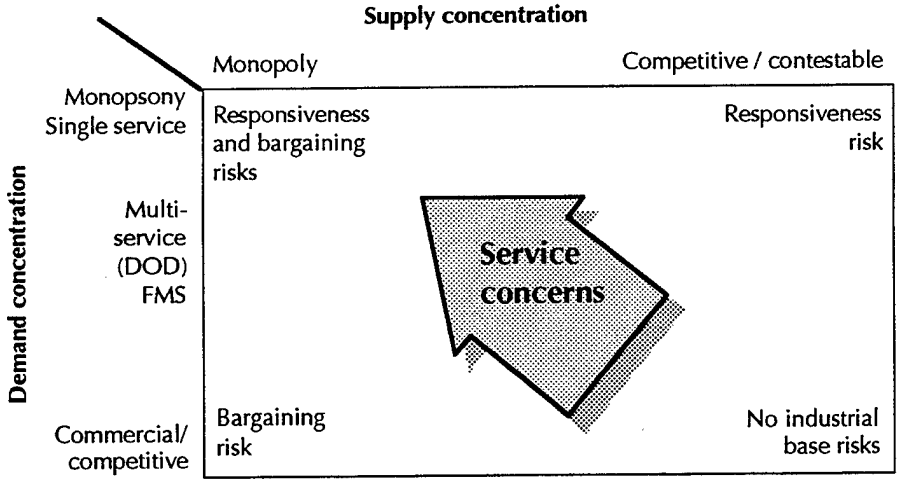
Non-industrial-base issues

In recent years, it has been fashionable to label many issues as industrial base issues. This paper will deal only with the risks just described because we feel that they form the core of legitimate industrial base concerns. Other issues, such as budget priorities, patentability of basic research, underfunding of public goods, externalities, and information asymmetry, will not be discussed here. These issues are always of concern and do not arise from changing demand and supply conditions. Therefore, this paper will not classify them as industrial base issues.

Summary of industrial base risks

Figure 2 summarizes many of the industrial base concerns dealt with in this paper. The horizontal axis lists supply concentration ranging from a sole (monopoly) supplier to a competitive industry. The vertical axis lists demand concentration from single service purchases (monopsony) to a competitive customer market. All points in the top part of the graph, where the DON is the primary purchaser, have responsiveness/capacity risks. All points on the left side of the graph, where there is a sole supplier, have bargaining risks.

Figure 2. Summary of industrial base risks



Each of the four corners represents a different equilibrium that may require its own set of responses. The most desirable position is the lower right-hand corner. This is a competitive equilibrium with many buyers and sellers. Unless there are specific disruption risks, the government should leave the equilibrium alone.

The upper right-hand corner is a monopsony situation with the Navy or Marine Corps being the sole purchaser. Here, there is a potential responsiveness/capacity risk. However, the Navy Department has enormous power to determine the shape and scope of the market.

The lower left-hand corner is a monopoly situation with one seller and many buyers. Here, the DON has little market power compared with the seller and is susceptible to price gouging. Because there is a wide customer base, however, the industry should be able to respond quickly to changing Navy and Marine Corps needs. The supplier may not be able to gouge the Navy Department specifically because other customers could resell the item.

The top left-hand corner is of special concern to Navy Department leadership. This is a bilateral monopoly with a single buyer and seller. Each has significant market power, and it is not clear which will prevail. Here, both types of risks interact and can magnify each other. A supplier may reduce its capacity below Navy or Marine Corps needs as a bargaining chip to demand higher prices.

Theoretically, disruption risks may exist at any point. However, they are more likely to occur closer to the top left-hand corner.

Although the graph illustrates where potential industrial base risks exist, it indicates neither how likely those problems are to occur in actuality nor their potential severity.

Mitigating factors

Even when an industrial base risk exists, it may not be severe enough to warrant action. There are many mitigating factors that can reduce the severity of the risks for a particular industry. Some of these factors include availability of substitutes, ease with which new firms can enter the market, size and certainty of future demand, and cost-effective storage. Both the types and severity of risks need to be analyzed before appropriate policies are implemented.

General solution strategies

There are general solution strategies that can be employed to deal with each type of industrial base risk. A solution would be an action or series of actions that the Department of the Navy can take to prevent or substantially alleviate industrial base risks. Broad solution

strategies are outlined below. A more detailed discussion occurs in the final methodology stage.

Severe responsiveness/capacity risk arises from concentrated demand and can be countered in two ways: either by enlarging the customer base or by encouraging firms to maintain their capabilities. Strategies for expanding the customer base include foreign military sales (FMS) and dual-use technologies.

Encouraging firms to maintain capacity frequently involves some form of subsidy to facilities or human capital. Physical facilities may be subsidized by construction grants, joint public/private ownership, or direct government ownership. Human skills can be subsidized in several ways, including subsidizing training, providing interim work, or encouraging commercial conversion.

An alternative strategy for encouraging firms to maintain capacity is to have innovative contracting and profit incentives to reward companies that anticipate Navy and Marine Corps needs. Reference [3] discusses how profit policies can induce firms to invest in research and development before contracts are signed. Although theoretically sound, these may be politically difficult to implement.

Severe bargaining risk arises from concentrated supply and requires different policies. Here, regulation or deregulation tends to be the key. If there are barriers to entry, they should be removed to permit competition. If that is not feasible, direct profit regulation may be necessary.

Bargaining risk due to economies of scale poses different challenges. Here, policies encouraging competition may be very expensive because they require an inefficiently small level of production in each firm. Alternatively, a noncompetitive allocation of work also may be costly. The best solution may be to do nothing or to have some sort of government regulation, similar to the oversight of utilities.[3]

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3. Reference [7] contains a brief history of economists' views toward monopoly.

Severe disruption risks may require strategies, such as added physical protection or diversification. Physical protection may entail added private or military security to prevent terrorism or sabotage. Physical diversification involves Navy Department policy to encourage separate production facilities. For example, two smaller facilities in different locations may be less vulnerable to disruption than one large facility. However, there may be significant efficiency tradeoffs when diversifying facilities in this manner.

Stage I: Filtering industrial base items

The first stage of the methodology helps define the industrial base item. One can misidentify an item too broadly or too narrowly. If the identification is too broad, there would be many subcomponents and producers involved, and it would be impossible or inappropriate to answer many of the later template questions. If the identification is too narrow, the item would have many substitutes and the industrial base for that item would not be of concern.

An example of an item that is defined too broadly would be *all ships.* The item is so large that it could not be covered in a single industrial base study. It needs to be broken down by size, type, propulsion (nuclear/nonnuclear), weapon systems, and so on. An example of an item that is defined too narrowly would be a *3-inch screw.* There are so many substitute methods of attaching items (nails, rivets, welds, 3.5-inch screws, etc.) that discussion of industrial base issues becomes pointless.

By assessing the number and types of substitutes for an item, one also gets a sense of the item's importance to the Navy or Marine Corps. In general, the greater the number of substitutes, the less critical the item. Even temporary substitutes will mitigate the severity of a possible shortfall and help establish the time frame required for resupply.

Two questions make up this initial filter:

- What are the key components?
- Are there substitutes for the item?

We will discuss both questions in further detail.

Question 1: What are the key components?

Purpose of question

A procurement item is the final output of a production process. As with any pipeline process, potential failures will most likely occur at the weakest points. Therefore, these points are the most critical to examine.

A comprehensive industrial base study will identify the key components that could halt or severely slow the production process. These components should be run separately through the industrial base templates and become part of the final study.

Answering the question

This is essentially an engineering question. Someone who understands the production process would have to list the key components and identify process bottlenecks.

Question 2: Are there substitutes for the item?

Purpose of question

This question aims to ensure that the item definition has the proper scope and to measure its importance. If there are good **permanent substitutes** for an item, it is probably defined too narrowly. For example, if the item is number 2 nails, and number 3 nails will suffice perfectly, the item is defined too specifically.

Even if there are no permanent substitutes for an item, there may be **short-term substitutes** that could be used as temporary stopgaps in the event of a shortage. These stopgap strategies help define the length of time required for a ramp-up. In general, longer ramp-up times allow for easier industrial adjustments. Continuing with the nails example, if supplies were interrupted, there probably would be other fastening methods that could hold until new supplies could be procured.

We divide short-term substitutes into two categories: **functional** and **mission**. Functional substitutes are temporary fixes that allow equipment to function. For example, radiator hoses are necessary for operating a jeep. If a hose breaks, however, one can probably use duct tape to patch it until a new hose is found. A short-term interruption would not bring the jeep to a halt.

Mission substitutes are other pieces of equipment that can accomplish the same general mission. These can serve as contingency backups in case an item becomes unavailable. In the jeep example, if the failure does render the jeep temporarily inoperable, there might be a truck or other vehicle that could be used to accomplish the same purpose.

This question identifies unique items with no good short-term substitutes. These are likely to be the most critical.

Answering the question

The key to answering this question is to ask what would the Navy or Marine Corps (or a contractor, in the case of a critical component)

do if supplies of the item were interrupted? How would they get around the problem? These are the substitutes.

Permanent substitutes will probably be fairly easy to recognize. Temporary stopgaps may be more difficult. They may be similar components with ad hoc modifications. They may be engineering sleights of hand, like duct tape. They may simply be keeping and better maintaining older equipment until new supplies can be procured. They may even be different deployment strategies that can be used if a piece of equipment is missing.

For mission substitutes, it may be helpful to list all the missions that a piece of equipment performs and identify other items that can perform each mission in the event of a shortfall. These substitute strategies will not be perfect; however, an assessment of how good or bad they are would help determine how much industrial base effort is warranted.

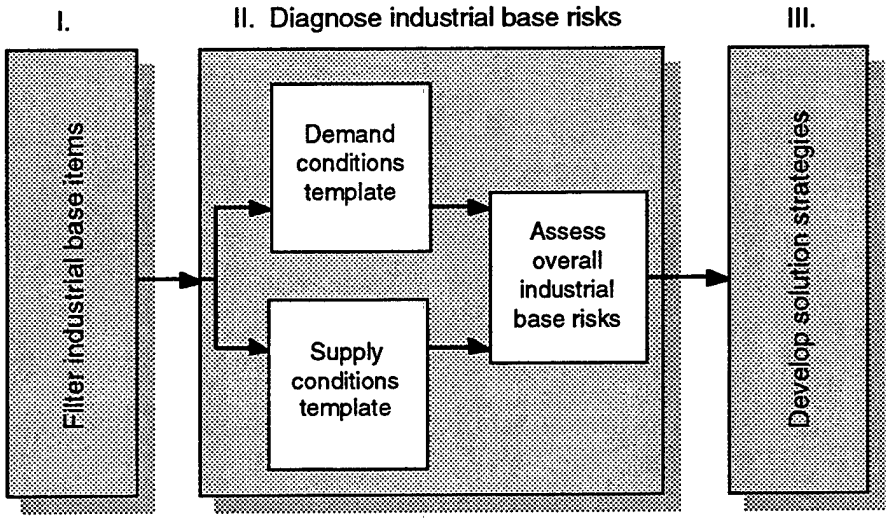
Stage II: Diagnosing industrial base risks

After the industrial base item is properly defined, the next stage is to diagnose the types and severity of any industrial base risks. Risks result from the interaction between demand and supply conditions, and diagnosing them requires three tasks:

- Analyze demand conditions.
- Analyze supply conditions.
- Assess overall industrial base risks.

The first two tasks are accomplished with the help of template questions. The third combines the two sets of questions to highlight the industrial base risk factors in the overall economic equilibrium. Figure 3 illustrates this process.

Figure 3. Stage II of overall methodology



The next two sections contain the demand and supply templates. The third section gives guidance for analyzing the resulting industrial equilibrium.

Stage II-A: Analyzing demand conditions

Stage II-A contains the template to analyze demand conditions for any specific procurement item. There are four major questions:

- Is the Navy Department the primary purchaser of this item?
- How likely is demand to expand in the future?
- Is demand predictable?
- Is the item storable at low cost?

This section describes each question in greater detail.

The goals of this template are to assess the competitiveness of demand, the likelihood of large or unexpected demand shocks, and the feasibility of one simple demand buffering strategy. The results of these questions will be combined with the supply template answers to produce a full industrial base assessment.

Question 3: Is the Navy Department the primary purchaser of this item?

Purpose of question

This question places the item on the vertical axis of figure 2. If the Navy Department is the primary purchaser, the industry exists to support the military. Consequently, there will be a potential responsiveness/capacity risk.

Answering the question

The researcher can answer how many purchasers there are for this item and what percentage of industry output goes to the Navy or the Marine Corps. Is this distribution of buyers expected to continue in the future?

Although many items that the Navy Department buys are unique in some way, often they differ from commercial products in only small or superficial attributes, such as size or color. In answering this question, the researcher should consider purchasers of very similar items also to be market participants. For example, when the military buys trucks, they tend to differ somewhat from commercial vehicles. However, the differences are not so great that commercial truck plants could not easily shift over to military production. In this case, the answer should include all purchasers of similar trucks. In other cases, judgment will be needed to decide which items are, in fact, similar and to determine the total number of customers for the industry.

Question 4: How likely is demand to expand in the future?

Purpose of question

This question determines how likely it is that the Navy or Marine Corps will need additional capacity. Although a responsiveness/capacity risk may exist in an industry, it will only become a problem during an actual ramp-up. This question takes into account the likelihood of scenarios that could change Navy Department requirements.

Answering the question

There are two basic strategies for answering this question. One can look at either future projections or past histories.

Future projections could indicate expanding procurement needs. For example, current requirements may call for increasing future purchases. Various scenarios can be considered to assess how likely a future ramp-up may be.

Past histories may also be good indicators of change. Procurement items that have fluctuated greatly in the past may continue to fluctuate in the future. If current procurements are low, they may expand again in the future.

Possible increases in demand should be compared with current output levels to measure the adjustments required relative to the industrial base.

The researcher should also try to verify that any increased demand is actually for the same item. Technology advances very rapidly, and sometimes new items bear little resemblance to those they replace. An item's future mechanisms and production techniques may require a whole new industry. The researcher needs to consult with experts to ensure that the item will remain relevant. The longer range the industrial concern, the more difficult it is to plan for new technologies.

Question 5: Is demand predictable?

Purpose of question

This question determines how much advance warning the Navy may have for a future ramp-up. The more time available, the easier it is for industry to adjust production, and the fewer the responsiveness risks.

Answering the question

One way of answering the question is to look at previous forecasts of Navy procurements and check their accuracy against actual purchases. The accuracies can be measured as a function of how far in advance the forecasts were made. Demands that were highly predictable in the past may continue to be predictable in the future. Forecasts that were highly inaccurate in the past may also continue.

If various scenarios are being considered, the analyst should consider how much advance warning there would be. How likely is it that an immediate ramp-up would be needed versus a gradual one?

The goal for an answer would be to have a time interval (perhaps in years) for how far in advance a reasonably accurate forecast of requirements can be made. This predicted interval then should be compared to the normal production and lead times for the item to determine how quick a ramp-up may be required.

Question 6: Is the item storable at low cost?

Purpose of question

If future demand is predictable, storage is one strategy for avoiding responsiveness/capacity risks during a future ramp-up. Private industry or the Navy Department itself could hold inventories for future demand. This strategy could also provide protection against disruption risks, and reduce the bargaining power of sole suppliers during national crises.

An inventory strategy should be approached with caution. It can be expensive and wasteful. Items that have easy substitutes or whose supply can be increased quickly should not be stored. The Navy and Marine Corps should rely on the free market whenever possible.

Answering the question

There can be many costs to storage. Standard costs typically include warehousing, spoilage, and opportunity costs of capital. Military storage, however, may have other costs. Technology depreciates very rapidly and missions can change with international conditions. Yesterday's equipment may be of little use in tomorrow's conflicts.

One way of answering this question would be to estimate these costs directly. Another way would be to look at similar items that the military has stored in the past. How expensive was that storage? Did the item require significant overhauls before it was used? How well did it perform?

Even if it is not cost-effective to store a final product, intermediate products may be stored. They may cost less, yet significantly decrease the time required for a future ramp-up. In many cases, with the correct incentives, these intermediate inventories could be stored and managed by private industry.

Stage II-B: Analyzing supply conditions

Stage II-B contains the template to analyze the supply conditions for any specific procurement item. There are four major questions and three subquestions:

- How many suppliers are there for this item?
- Is it easy for current suppliers to increase production?
- How easy is it for new suppliers to enter the market?
  - — Are there barriers to entry?
  - — How many likely entrants are there?
  - — How expensive is it for potential suppliers to enter the market, and how efficient will they be?
- Are industrial facilities and processes vulnerable to disruptions?

This section describes each of these questions in greater detail.

The goals of this template are to assess the competitiveness and flexibility of supply. Answering these questions not only assesses bargaining and disruption risks, but also helps analyze mitigating factors for all industrial base risks.

Question 7: How many suppliers are there for this item?

Purpose of question

This question places the item on the horizontal axis of figure 2. If there is a single supplier or very few suppliers, they may have significant market power leading to potential bargaining risks. Where there are many suppliers, competition will prevent gouging and holdup problems.

It is important to emphasize that having few suppliers does not automatically mean there is a bargaining risk. Subsequent questions will assess the amount of market power actually held by these companies.

Answering the question

The number of suppliers includes all firms with the current capability to produce an item. Compare this answer with the expected number of future suppliers to help determine industrial base risks down the road.

To assess the relative market power of these suppliers, researchers should look at concentration ratios and Herfindahl-Hirschman indexes. Reference [8] contains a good discussion of these indexes.

Question 8: Is it easy for current suppliers to increase production?

Purpose of question

This question assesses the flexibility of production techniques used by current suppliers. If it is very easy to increase production rates quickly, this should alleviate responsiveness/capacity risks. The Navy Department needs to pay attention to items where production requires long lead times or high adjustment costs.

Answering the question

This question can be answered in two ways. An engineering assessment can determine current supplier capacity and adjustment costs. Past data can show recent actual capacity and adjustment rates; this may be a good indicator of future capabilities.

Question 9: How easy is it for new suppliers to enter the market?

Purpose of question

This is the most important industrial base question because it determines the contestability of the market.[4] It is also one of the most overlooked analyses. A market is contestable when any excess profits will be quickly competed away by entering firms. Easy entry by new firms can potentially alleviate all industrial base risks. Entering firms can increase an industry's output and reduce any responsiveness/capacity concerns. The threat of entry, itself, can diminish the power of single suppliers, thereby preventing bargaining risk. If existing suppliers experience severe disruption, new firms can step in to make up the slack.

Answering the question

This is, however, a very difficult question to answer. Three subquestions can help researchers get a handle on the issues involved:

- Are there barriers to entry?
- How many likely entrants are there?
- How expensive is it for potential suppliers to enter the market, and how efficient will they be?

4. Reference [9] contains a complete discussion of contestability issues.

Question 9-A: Are there barriers to entry?

Purpose of question

For industries with one or very few firms, this question identifies the source of their market power. Identifying the source of market power helps pinpoint effective solutions.

Barriers to entry can be divided into two categories: artificial and natural. Artificial barriers include legal restrictions, environmental regulations, military specifications, and the like. These barriers tend to restrict entry and thereby protect current suppliers. Wherever possible, the Navy Department should work to break down these barriers to encourage competition.

If there are few firms with no artificial barriers, there may be natural barriers. Natural barriers are chiefly forms of economies of scale. Economies of scale result when the demand for an item makes it optimal for very few firms to produce for the entire market. In addition, there may be economies of scope, where it is cost-effective for companies to produce different lines of similar products, such as different types of aircraft or ships.

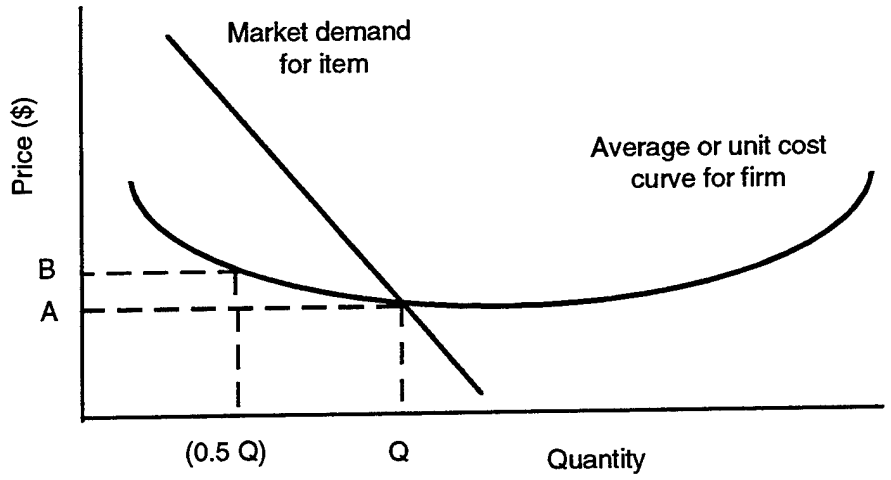
Figure 4 contains an example of economies of scale. Here, a single firm's average cost curves are declining even at the point where it satisfies the entire market demand, Q. If output Q were shared equally by two firms instead of one, costs per unit would rise from point A to B. In cases such as this, it may be very expensive to encourage competition. Regulating the natural monopolist's profits or doing nothing may be the only alternatives.

Answering the question

The researcher needs to examine whether there are artificial barriers, especially legal and environmental constraints. Military specifications and contracting rules may also be highly burdensome.

Assessing natural barriers will be harder. There are several strategies to assess whether there are economies of scale.

Figure 4. Demand and cost curves with economies of scale



One way is to try to measure the optimal firm size. Optimal firm size is typically measured by which firms survive; historical data may be used to gauge this optimal size over time and compare it to current market demand. Stigler discusses optimal firm size and economies of scale in [10].

Another way of assessing economies of scale would be to check whether a firm exhibits declining marginal costs. Reference [4] discusses measuring these costs.

High learning rates can also create economies of scale. When tasks are repeated, the time and resources required to complete the tasks often decline. This is called learning. If learning by doing is present in an industry, the amount of resources required declines as cumulative production increases. These rates are usually logarithmic. For example, a 70-percent learning rate means that the second item produced requires only 70 percent of the resources of the first; the fourth requires 70 percent of the resources of the second, and so on. Technological changes to product lines may reduce learning effects significantly. References [11] and [12] contain discussions of measuring learning rates.

Question 9-B: How many likely entrants are there?

Purpose of question

This question determines the true scope of the market and assesses the level of competition.

Answering the question

Likely entrants would be firms that have some comparative advantage in the industry. These could be former suppliers, firms making similar items, or firms with some special expertise that could be applied to the industry.

Government-owned facilities may also be potential entrants. Some facilities may be adapted to production in times of national need. Government facilities can help provide some degree of competition in a market, although they are usually more expensive and less flexible than private industry. Government-owned facilities also can provide important engineering and cost information about production processes; this could be valuable when overseeing private contractors.

Question 9-C: How expensive is it for potential suppliers to enter the market, and how efficient will they be?

Purpose of question

This question tries to quantify the market power of existing firms. The cost of new firms entering the market and their subsequent cost efficiencies reveal the maximum amount that a sole supplier can gouge the Navy or Marine Corps. If they try to gain more, the DON could save money by bringing other suppliers into production. This amount is also the maximum disruption cost, should existing supplies be interrupted.

Answering the question

This also is a very difficult question to answer. One strategy is to look at past histories of shutdowns and startups. If a company had previously entered the industry, the associated costs and time lags can be investigated. When they were producing, how did their costs compare with other firms in the industry?

Another strategy is to try to directly estimate the costs and availability of inputs. Are there physical facilities that can be adapted for production? Is there a pool of skilled labor? How long does it take to train labor? How long does it take for a new facility to come online? Are there startup delays? How do labor costs compare to other firms in the industry? These may be difficult to answer exactly, but even rough answers will be valuable.

One additional cost related to new entrants is the search cost to the Navy and Marine Corps. Not all entrants will be reliable enough or responsive enough to meet Navy Department requirements. Finding such reliable suppliers may be an expensive process. In some cases, the Navy or Marine Corps may not be able to assess the quality of a purchase until long after delivery. This may be very expensive, especially for big-ticket items. This search cost may be very difficult to estimate ahead of time. Technical personnel may provide some guidance as to which items are easy to test for quality and reliability. For example, the quality of ammunition may be very easy to verify, whereas it may be very difficult to assess the long-term reliability of a submarine.

Question 10: Are industrial facilities and processes vulnerable to disruptions?

Purpose of question

This question assesses disruption risks. Although an industrial base study can provide some insight, the likelihood of a disruption is essentially a judgment call.

Answering the question

Three types of vulnerabilities need to be assessed: threats to facilities, to companies, and to the overall production process.

Threats to facilities would include terrorism, acts of sabotage, acts of war, natural disasters, and other physical threats. Researchers can gather data about weather conditions and the likelihood of natural disasters (earthquakes, floods, and fires). Other risks, such as acts of terrorism, probably require a military assessment.

Threats to companies would include labor disputes and bankruptcies. A firm may have a history of labor disputes that might indicate future problems. As discussed in the theory section, bankruptcies should not be a problem if the Department of the Navy is accepting honest bids from reliable contractors.

Threats to the production process may be threats to the transportation network linking contractors with subcontractors. Foreign production of key components may also be such a threat because it may subject supplies to international politics and long transportation networks.

Stage II-C: Assessing overall industrial base risks

Stage II-C involves taking the answers from the demand and supply templates and creating an overall risk assessment. Table 1 lists all the questions that are relevant to assessing the severity of each type of industrial base risk.

Table 1. Summary questions for industrial base risks

Questions	Responsiveness/ capacity risk	Bargaining risk	Disruption risk
What are the key components?	X	X	X
Are there substitutes for the item?	X	X	X
Is the Navy Department the primary purchaser of this item?	X		
How likely is demand to expand in the future?	X		
Is demand predictable?	X		
Is the item storable at low cost?	X		X
How many suppliers are there?		X	
Is it easy for current suppliers to increase production?	X		
How easy is it for new suppliers to enter the market?	X	X	X
Are facilities vulnerable to disruptions?			X

There is no easy metric to come up with a final answer. The template questions lay out the relevant issues and filter away extraneous matters. The questions will vary in importance depending on the item being examined. Researchers and decision-makers will have to use careful judgment to decide whether the industrial base risks warrant special Navy Department or other government action. Examples of how to do this are contained in volume II of this document [2].

Stage III: Developing solution strategies

Once the researcher decides that industrial base risks are severe enough to warrant further investigation, the methodology can provide guidance for developing solution strategies. Each type of risk (capacity/responsiveness risk, bargaining risk, and disruption risk) will have its own set of solution strategies.

For an industrial base risk, the costs of the best solution strategies can be estimated and compared to their benefits. The researcher should try to evaluate the cost, quality, and availability of procurement items under different policies. Some policies may improve all three attributes; however, frequently there will be tradeoffs.

The following subsections describe the solution strategy sets for the different industrial base risks. Some policies may help alleviate several risks, but others will be extremely specific.

Solutions for responsiveness/capacity risk

Because responsiveness/capacity risk arises from concentrated demand, one way to alleviate the risk is to widen demand for the product. Widening demand usually entails enlarging the customer base for a particular industry. Where this is not feasible, the Navy and Marine Corps can encourage firms to maintain or expand their capabilities.

Widening demand

One way to widen demand for procurements is through foreign military sales. FMS will encourage firms to increase their production capabilities. This extra capacity could be used by the Navy Department in times of national need. However, there are many political and security problems associated with FMS and the ensuing technology transfers.

Another way to widen demand is to use dual-use technologies or off-the-shelf purchases. Where possible, the Navy and Marine Corps could purposely pick technologies and procurement items that are similar or transferable to commercial items. This should ensure that firms are supplying not just the armed services, but commercial users as well. Again, widening demand in this way gets at the source of responsiveness/capacity risk—concentrated demand.

Encouraging firms to maintain capabilities

Private firms will maintain sufficient capacity to meet military needs only if they expect to receive a profit. Each firm calculates its expected future revenues and then subtracts its costs. If it expects to be profitable, the firm will remain in the market; if not, the firm exits. The Department of the Navy can use two general strategies to ensure future profitability: either reduce firms' costs or raise revenues.

Reduce or subsidize costs of maintaining capabilities

The Department of the Navy may try to directly subsidize the costs borne by the firm. Here, the DON can directly pay for physical facilities either by grant or by a form of joint or direct ownership. The DON can directly subsidize human skills by paying for training or subsidizing specific types of education.

The Navy and Marine Corps may also indirectly subsidize industry costs. Possible strategies include providing interim work, stretching out procurements, and providing related types of work, such as design or repair. All these policies have a common goal—to keep personnel trained and equipment in working order to reduce capability maintenance costs to the firm.

The act of subsidizing an industry carries risks of its own. Subsidies not only "protect" an industry but distort the marketplace, creating inefficient allocations of resources. The Navy Department or other parts of the government have to decide which firms, which facilities, and which production technologies to subsidize. This requires picking winners and losers in the market. Over time, it runs the risk of rooting the military in past technologies, undermining market efficiency, and stifling new innovative techniques.

Subsidies may protect an industry's short-run responsiveness and capacity by current techniques. However, there may be greater efficiency in using more modern technologies. In this case, the protected facilities may no longer be the most cost-effective, and the prior subsidies would have been wasted. Worse yet, subsidy programs may subject the market to political interests that can persist long after a program's usefulness has disappeared. Subsidies generate political constituencies with vested interests in protecting the status quo.

A different way to reduce costs without subsidies is acquisition reform. Acquisition reform aims to lower costs to firms by reducing bureaucratic burdens, such as contract procedures or military specifications. By reducing a firm's costs, the Navy and Marine Corps encourage existing firms to remain in the market and other commercial firms to enter.

Increase potential revenues

Instead of trying to reduce an industry's costs, the Navy Department can try to increase expected revenues. In most cases, these actions involve contracting and acquisition reform policies. Contracts can be awarded based on speed and quality over costs; this would provide incentives for firms to maintain ready capacity. Longer term contracts can take some of the risk out of future revenue streams and thereby help firms maintain capabilities in the market. Finally, a DON commitment to future profits will encourage suppliers to maintain capacity and innovation.

Such innovative contracts can significantly alter a firm's behavior. For example, consider the contract used for reconstructing the Los Angeles freeways after the earthquake in January 1994. Governor Pete Wilson signed an emergency executive order suspending bid-taking regulations to speed the process of awarding contracts. In addition, the California Department of Transportation used an incentive/disincentive clause in contracts where a clear benefit could be calculated. C.C. Myers Inc., which was awarded the $14.9-million Santa Monica freeway project, was to earn a $200,000-bonus for each day the project was finished ahead of schedule and would have to pay that same amount for each day it was late. Myers was given 140 days to complete the job. By working around the clock, using expensive

quick-drying concrete, and renting a train, extra equipment, and a fleet of trucks, the company was able to finish the project in 66 days and earn a $14.8-million bonus [13].

The example demonstrates that innovative contracts and streamlining the acquisition process can benefit timeliness. They can also benefit quality or other procurement attributes. If such contracts were awarded on a regular basis, firms would anticipate this and maintain additional capabilities in preparation.

Solutions for bargaining risk

Bargaining risk is less concerned with industrial capacity than with the number of possible suppliers. Here, policies toward regulation and deregulation are central. The correct policy will depend on the type of entry barriers present in the industry: artificial or natural. This subsection describes each case.

Artificial barriers

Artificial barriers are legal and bureaucratic constraints that limit competition. Examples are environmental and licensing regulations. These regulations can shield existing firms from new market entrants. The best economic policy is to try to remove these restraints to permit competition. If removing an artificial barrier is not an option, it may be desirable to prevent sole suppliers. Caution is required to ensure that there are not large economies of scale; otherwise, multiple suppliers may not be cost effective.

One possible DON policy is to assign work among current suppliers to ensure that they remain in the industry. However, nobody should confuse this with true competition.[5] Strict assignment among two or more firms is similar to the Department of the Navy dealing with the same number of mini-monopolies. It is only the threat of losing work and going out of business that truly prevents price gouging.

5. Pilling, in reference [14], cautions that claims of savings from limited competition in defense procurements may be overstated.

Another policy option is utilizing innovative contract mechanisms to encourage limited competition among protected firms. An example would be giving the firm with the lower costs a greater profit rate, while accepting limited higher bids. This option is neither true competition nor assignment, but somewhere in between. Such mechanisms are costly because the procurements are not always awarded to the lowest bidder, and they also risk subsidizing technologies for the future.

If artificial barriers result in sole suppliers despite contracting efforts, direct government regulation may be the only response. The firm could be regulated to prevent monopoly profits. In some cases, however, the mere threat of regulation may be enough to prevent price gouging.

Natural barriers

Natural barriers are economies of scale and scope that make it most efficient for one firm to service the market. In this case, policies using some form of work assignment to ensure "semi-competition" may be extremely expensive. By encouraging multiple suppliers, firms would be producing on an inefficiently small scale, and costs per unit could be very high.

For example, it would be inefficient for a city to permit many small water companies to lay pipes crisscrossing the community. Therefore, municipalities typically grant a monopoly to just one company and then regulate its profits.

The Department of the Navy and the federal government can follow a similar strategy. They can purchase from a sole supplier, while regulating its profits.

However, a policy of profit regulation risks stifling innovation. Wherever there are large profits, there is an incentive for new firms to enter. In the case of a natural monopoly, the new entrant may seek a more efficient technology to capture the entire market for itself, and current suppliers must be constantly vigilant. If profits will be regulated away, nobody will have any incentive to innovate. In the case of natural monopolies, the best policy may be to do nothing.[6]

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6. Reference [15] discusses this point further from the Austrian economic perspective.

Solutions for disruption risk

Disruption risk can be alleviated by adding physical protection to existing firms to counter risks of terrorism or sabotage. Alternatively, government policy can encourage geographic diversity among companies or facilities. For example, two small factories in different areas may be less vulnerable than one large, centralized facility. This is very similar to using a diversified portfolio of stocks to reduce risk; adverse conditions are more likely to affect one area than all areas. Researchers should consider efficiency tradeoffs because two small facilities may be far more costly than one large one.

Solutions for combined risks

When responsiveness/capacity risk is combined with bargaining risk, the problems become more complex. For example, sole suppliers may reduce their capacity as a bargaining chip to demand higher prices. This is a monopolist/monopsonist case in which each party has bargaining power; it does not have a formal solution in the literature. Reference [16] contains a rigorous theoretical discussion of the issues involved in this sort of "bilateral" monopoly.

Nevertheless, some policies may alleviate all industrial base risks. For example, if the Navy or Marine Corps can create broad substitutes for an item, that will weaken a monopolist's bargaining position and allow for contingency backups should responsiveness become a problem. Acquisition reform can also alleviate all risks. By making it easier for commercial firms to enter, the Navy Department increases the contestability in the market and facilitates industrial conversion during ramp-ups.

Certain policies, such as dual-sourcing, are thought to alleviate all risks, but actually will not. If the Department of the Navy is committed to assigning work, even partially, it is unclear how much competition will take place. Also, dual-sourcing does not necessarily mean more capacity. Two small firms may not be able to ramp up faster than one large one.

Conclusion

This paper presented a framework to help the Department of the Navy conduct industrial base studies. Applying the methodology will guide the Navy and the Marine Corps toward better industrial base analyses and policies by:

- Focusing on critical economic causes of industrial base concerns
- Filtering out extraneous issues
- Identifying specific risks for industries
- Identifying solutions tailored to alleviate those risks
- Avoiding policies mismatched to actual industry risks.

The templates and analyses not only help identify risks but also form a baseline for assessing different policy solutions. For any proposed solution, the templates would show which risks would be alleviated, which would remain, and which may be exacerbated.

For example, consider a policy of maintaining two nuclear shipyards. The templates point out that this would be particularly effective in combating potential disruption risks. Two geographically dispersed facilities are less vulnerable than one concentrated facility. However, it is not necessarily true that this would decrease the responsiveness/capacity risk. As the template points out, two smaller shipyards may or may not be as capable as one larger facility. Also, depending on how the policy is implemented, it may not decrease bargaining risk. If the Navy Department assigns work, overall competitive pressures may decrease, resulting in greater price gouging and bargaining risk. Given these effects on industrial base risks, the DON can estimate possible costs and then come to a decision. If disruption risk is the Navy's primary concern, a two-shipyard policy might be desirable even with a possible cost premium.

In this manner, the methodology ensures that proposed solutions actually abate the specified risks. Many potential policies will be filtered out immediately. The few policies that remain can be studied in further detail. The industrial base methodology will provide a head start for performing that analysis by identifying those characteristics of the market likely to change from a particular policy.

References

[1] CNA Information Memorandum 408, *Industrial Base Bibliography,* by Monica J. Giovachino and R. Derek Trunkey, Mar 1995

[2] CNA Research Memorandum 95-113, *Performing Industrial Base Analyses, Volume II: Applying the Methodology—Surface Combatants and Torpedoes,* by Glenn H. Ackerman et al., Business Sensitive, Aug 1995

[3] RAND Report R-3635-PA&E, *Profit Regulation of Defense Contractors and Prizes for Innovation,* by William P. Rogerson, 1992

[4] Dennis W. Carlton and Jeffrey M. Perloff. *Modern Industrial Organization.* Glenview, IL: Scott, Foresman and Company, 1990

[5] Edwin Mansfield. *Microeconomics.* 5th ed. New York: W. W. Norton & Co., 1985 (pp. 277–278)

[6] CNA Research Memorandum 94-172, *Downsizing the Defense Industrial Base and Implications for U.S. Shipbuilding,* by Jonathan W. Leland, Oct 1994

[7] George J. Stigler. "The Economists and the Problem of Monopoly." *American Economic Review, Papers and Proceedings,* Vol. 72 (1982): 1

[8] F. M. Scherer and David Ross. *Industrial Market Structure and Economic Performance.* 3rd ed. Boston: Houghton Mifflin Company, 1990

[9] William J. Baumol, John C. Panzar, and Robert D. Willig. *Contestable Markets and the Theory of Industry Structure.* New York: Harcourt Brace Jovanovich, Inc., 1982

[10] George J. Stigler. "The Economies of Scale." *Journal of Law and Economics*, Vol. 1 (October 1958); reprinted in *The Organization of Industry*. George J. Stigler. Chicago: University of Chicago Press, 1983

[11] Armen A. Alchian. "Reliability of Progress Curves in Air-Frame Production." *Econometrica*, Vol. 31 (1963): 679

[12] Linda Argote and Dennis Epple. "Learning Curves in Manufacturing." *Science*, Vol. 247 (1990): 920

[13] Barry Wise. "Rising From the Rubble: Los Angeles Repairs Its Roads." *American City & County*, Dec 1994 (p. 109)

[14] Donald L. Pilling. *Competition in Defense Procurement*. Washington DC: The Brookings Institution, 1989

[15] Paul R. Ferguson and Glenys J. Ferguson. *Industrial Economics: Issues and Perspectives*. 2nd ed. New York: New York University Press, 1994 (p. 106)

[16] Jean Tirole. *The Theory of Industrial Organization*. Cambridge, MA: The MIT Press, 1988 (pp. 21–29)

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